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ABSTRACT

This paper deals with the problems of rigorous research within the dynamic organizational context. Definitions and axioms establish the natures of a social problem, a social intervention program, continuous program monitoring, a method of describing alternative treatments, treatment effect testing, and programmatic change. These definitions and axioms are used to prove indirectly that programmatic change is compatible with rigorous research. A major conclusion is that research designs are applicable to the structural study of organization and that they permit a study of the managers' reactions to feedback in a real world situation. The use of research designs will thus permit the establishment of a causal theory of management and organizations. (Author/LLR)

STRUCTURAL MODELS AND DYNAMIC ORGANIZATIONAL RESEARCH: A POSSIBILITY THEOREM

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Abstract

Without rigorous research designs and the attendant control of the distribution of random effects, it is impossible for the study of organizations to proceed as a nomothetic discipline. While it is clearly possible to describe organizations, as with case studies, and predict shortrun trends, as with simple extrapolation of organizational attributes, the examination of the structural models which underlie the basic behavior is practically nonexistent. This point has been made by social psychologists such as Kurt Lewin, game theorists such as Oskar Morgenstern, and sociologists such as Stanley Seashore.

If the problems encountered in rigorous research were simply practical, as enumerated for instance by Seashore, they could be overcome by diligence and adequate resources. It has been proposed, however, that there is a logical incompatibility between the application of design and the dynamic study of organizations. It is argued on methodological grounds that if preliminary research findings are disseminated during the research cycle (in simplest terms, between pre- and post-measures), then the organizational management may use these findings to modify operations or organization during the cycle. This sort of modification practice, to achieve project improvement, (so the argument goes) will corrupt the design and render the research meaningless.

This argument has two shortcomings. On the one hand, it is ill-formulated. When imprecisely formulated, it is difficult to ascertain the force and focus of the argument. On the other hand, when the discussion is rigorously formulated, the argument is shown to be false.

In this presentation, we undertake to give the discussion a precise statement. Briefly, the definitions and axioms that follow establish: (A1) what is a social problem; (A2) what is a social intervention program; (D1) what is continuous monitoring of the program; (D2) how are alternate treatments described; (D3) what is a test of treatment effects; (A3) what is programmatic change. These definitions and axioms establish the structure of a social action program, where treatment change occurs as a function of evaluative feedback. They are also sufficient to examine the possibility of conducting rigorous (Fisherian) research on such a program.

These definitions and axioms are the basis of proof of a theorem to the effect that programmatic change is compatible with rigorous research. This theorem has clear implications for the need for a field theory in the social sciences.

In summarizing our findings, it can be concluded that research designs not only are applicable to the structural study of organization, but also permit the study of the manager's reaction to feedback in the real world situation. The use of such research designs will thus permit the establishment of a causal theory of management and organizations.

Reading Text

While experimental designs are frequently used in research within an organization, for example, industrial research applications, these designs are rarely applied to the study of an organization and its management. J. L. Price has recently pointed out that rigorous research designs are virtually unknown in the study of organizations.[1] Seashore in his discussion of the problems and prospects of the utilization of rigorous designs, points out that the five or ten attempts to use designs which are reported in the literature are "primitive, pioneering ventures."[2]

It is not difficult to explain why the organizational researcher has tended to case studies and anecdotal evidence. The universe of organizations is ill-defined; the number of units accessible to an investigator is small. The organizational patterns are myriad; although the development of graph theory has showed promise, in general the analytical tools of mathematics are of limited application. All this has combined to favor description rather than rigorous inference.

Of course, causal inference in research can be permitted only when rigorous designs are employed. Without designs it is impossible to construct a genuine theory of organizations and their management. Work done without experimental designs has given rise to a plethora of untested taxonomies. This lack of design is particularly striking when organizations in a dynamic context are considered. Here management can be seen as the "motor" which drives the organization closer and closer to an approximation of an ever-modified set of goals, the movement toward which is always subject to environmental constraints. In this explicitly

dynamic context, the necessity for rigorous designs in theory construction is patent, but the application of these designs is quite problematic.

Among the critical problems in this dynamic situation is the centralization of control in the organization. The researcher's problems of inference are considerably simplified when classical control theory is applicable to the organization. When the decision-making is decentralized, the relationship between actors in the organization becomes one of strategic interdependence rather than autonomy, and the appropriate model is game theoretic rather than the simpler model of classical control theory. Notice that these are theoretical not methodological problems.

If the problems encountered in the employment of designs were simply the practical ones enumerated by Seashore, they could in principal be overcome by diligence and adequate resources. The same is true of the theoretical considerations alluded to above. It has been proposed, however, that there is a logical incompatibility between the application of design and the dynamic study of organizations. The first premise of this logical argument is that if preliminary research findings are disseminated during the research cycle, in simplest terms, between pre- and post-measures, then the management may use these findings to modify operations or organization during the cycle. This sort of modification practice, to achieve organizational improvement, so the argument goes, will corrupt the design and render the research meaningless. The other premise of the logical argument is that the researcher either is ethically prescribed to publish the preliminary findings, or else is under a monetary sanction to do so. From these premises, the conclusion of incompatibility is drawn.

As Patrick Suppes has pointed out,[3] the problem of an impossibility theorem is acute: he suggests that more care is needed to prove a negative argument than a positive argument. Yet a large number of alleged

impossibilities are continually asserted in the social sciences. Most of these arguments are vague, proceeding from nebulous premises. The argument before us is a case in point. As formulated, it is vague. When given a more precise formulation, it vanishes.

We have discussed elsewhere this logical argument as it applies to the management of educational programs[4] and family planning programs.[5] The claim that early dissemination of research findings will render the study invalid has also been made with regard to juvenile delinquency programs,[6] foreign aid development programs,[7] programs in the War on Poverty,[8] and training programs.[9] This claim may in part have given impetus to the rise of operations research in other areas of management,[10] and certainly had a bearing on the Ford Foundation's refusal to fund organizations employing research designs, preferring to fund "action research" projects.[11]

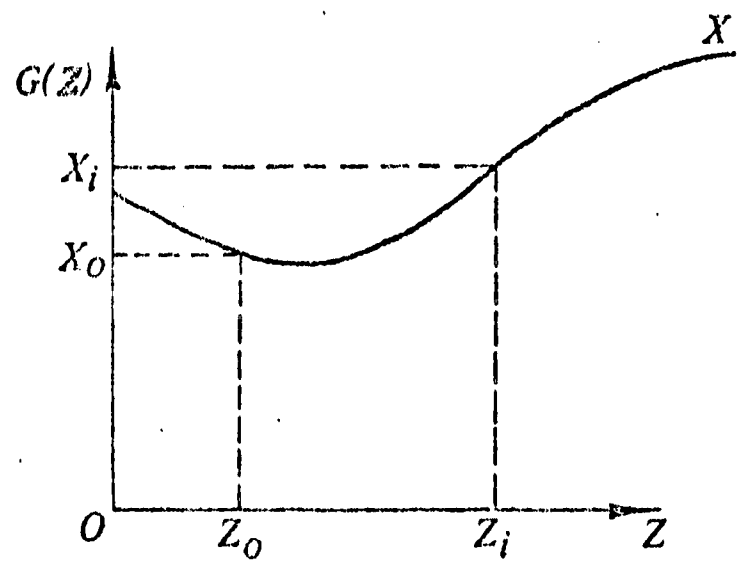
In this paper we present a general treatment of the problems of rigorous research in the dynamic organizational context. This discussion is specifically methodological, addressing itself to the demonstration of possibility by indirect proofs. Particularly we concern ourselves with organizations seeking to effect resolution of social problems. Although research has more frequently addressed itself to these particular organizations in the guise of "action research", it is not to be assumed that this restricts the general applicability of the findings.

These axioms and definitions of our proof, we suppose are sufficient to establish the structure of a social action program, where treatment change occurs as a function of evaluative feedback. They are also sufficient to examine the possibility of conducting rigorous (Fisherian) research on such a program, and are the basis of proof of a theorem to the effect that programmatic change is compatible with rigorous research.

The proof is included as an appendix to this paper. We will try now to motivate the essence of the proof by geometrical constructions.

Assume that an organization seeks to remedy a social problem. Implicit in the formulation of most social problems is the notion of an intolerable distance from a goal state, and a variable along which that distance is measured. Thus we can refer to the variable x as the measure of the social problem, and the magnitude of the problem as a difference between the actual and the desired values of the variable. So we hear that the crime rates, the accident rates, and the suicide rates are too high, while the employment rates, the Gross National Product, and the grade point averages are too low.

Given a set of resources or factors z, some technology G, transforms these inputs into an output described by the dependent variable x. Thus organizational behavior is a function G of a complex state of affairs z, intending to meliorate the social problem. Further, G and the set of independent variables Z are sufficient for the prediction of the organizational outcome in the absence of publication of G or z. This can be represented by the two dimensional diagram:

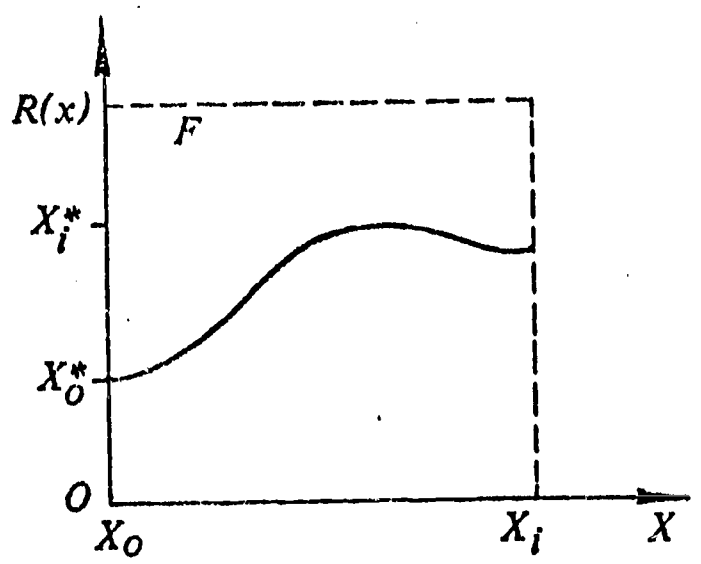


We note that for a given interval $[z_0, z_i]$, x will have a range of $[x_0, x_i]$. Thus x might be a measure of the lifetime learning power of Blacks in

contemporary America. The set Z would include such items as measures of prejudice, individual aptitude and achievement, socioeconomic status, etc.

If G is a social change process, we can imagine that if the organizational decision-maker discovered an evaluation indicating that some aspect of the process was tending to decrease the lifetime income of Blacks, then he would react to the report and change the process to a new value. The value of the output of the process would presumably change as well. Thus the prediction of program effects is made false by the act of publishing the prediction.

Let a reaction function R be introduced, indicating the dependence of the actual outcome on the knowledge on the part of the organizational decision-maker of the published judgment (or prediction). Given the relevant range $[x_o, x_i]$, we can represent the reaction function by the two-dimensional diagram:



With the variance of x through the range x_o to x_i will be associated a variance of the reaction between x_o^* and x_i^*. If R (x) is continuous over $[x_o, x_i]$, and if R(x) is bounded, i.e. $0 \leqq R(x) \leqq F$, then from point-set topology we know that there exists at least one value of each variable such that $x = x^*$. This is the fixed point. At the fixed point, the system described by the diagrams is in equilibrium, which is to say

that the organizational decision-maker will cease to react to x. Thus, that value of x is the correct public prediction, as well as the optimal state of the organization.

Thus we have shown (and the theorem of the appendix proves) that the argument against the use of research designs in a dynamic research context is based on an untenable first premiss. The dissemination of early research findings and the subsequent modifications in the operation or organization, instead of corrupting the design and rendering the research useless, can be viewed as making the design and the research more realistic. The distinguishing characteristic of the problem is the presence of feedback loops in the organization.

Let me make a few remarks of a historical character here. It would be misleading for me to present this as altogether new material. In the area of social science forecasting, bandwagon effects, and so forth, Grunberg and Modigliani,[12] and Herb Simon[13] proved a possibility theorem quite similar to this one. But perhaps even more interesting is the social psychologizing of organizational research that this theorem entails.

Our discussion gives partial support to Professor Argyris' proposal that

> Organizational theory is an appropriate theory to use to understand the human system created by rigorous research designs.[14]

Our support follows from viewing the research problem as a transaction or game. We say partial because specific "unintended consequences" mentioned by Argyris, such as dependency and so forth, appear to be substantive, not methodological, in nature.

Indeed Argyris' proposal has historical precedence in the methodological literature. For instance, Weber's concept of social action,[15] which is defined as those cases where an actor's behavior is meaningfully

oriented to that of another, should give the methodologist pause. Subjects of social science research do behave differentially and socially in the research context.

Indeed, this did give the methodologist pause, almost apoplexy, but misdirection too. Because Weber derived from this condition his peculiar dualism and Verstehende Wissensoziologie which has plagued the social scientist to this day. Weber (or his disciples) might instead have seen that passive research and understanding were not necessary conditions to the development of a "cultural science." Had he realized that a necessary condition was the recognition of the strategic interdependence of actors by various feedback mechanisms, needless discussion might have been avoided. But then he would have anticipated game theory by a decade or two.

On the other hand, Kurt Lewin saw the need for explicitly introducing a reaction function into organizational research. We needn't belabor the significance of his concept of the "gatekeeper" in his theorizing on social channels.[16] Had the aforementioned proponents of the impossibility of rigorous research read Lewin, they might have recognized that if the decision-maker is a significant factor in organizational outcomes, then his behavior must be explicitly considered in the research plan. A moments thought will convince you that the unequivocal partitioning of degrees of freedom will not allow the decision-maker's behavior and the behavior of the subject of his decisions, the organization, to be simultaneously introduced as variables. The identification problem is not unique to economics. Thus we are reminded of the necessity of a Lewinian field theory for a comprehensive theory of organizations.

In summarizing our findings, it can be concluded that research designs not only are applicable to the study of organizations, but also permit the study of the manager's reaction to feedback in the real world

situation. The use of such research designs will thus permit the establishment of a causal theory of management and organizations.

APPENDIX *

Briefly, the definitions and axioms that follow purport to establish: (A1) what is a social problem; (A2) what is a social intervention program; (D1) what is continuous monitoring of the program; (D2) how are alternate treatments described (D3) what is a test of treatments effects (A3) what is programmatic change. These axioms and definitions, we suppose, are sufficient to establish the structure of a social action program, where treatment change occurs as a function of evaluative feedback. They are also sufficient to examine the possibility of conducting rigorous (Fisherian) research on such a program.

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* We would like to thank Professor Wm. Beck and John Curry of Chatham College for their helpful criticism and comments. Of course, responsibility for any errors remaining rests with the authors.

Axiom 1: There is a decision function D on a set of nonnegative vectors ξ, where ξ is in the domain of D, if $|\xi - \zeta| \geq \gamma$. A subset of ξ is the set g. This function defines a social problem, where the state of affairs is not tolerably near to a desirable value g. The threshold of tolerance is given by the parameter γ.

Axiom 2: There is a set Φ of all treatment programs. A given treatment program consists of a set of technologically feasible vector pairs (x, y). One of these vector pairs consists of a nonnegative input vector x and a nonnegative output vector y. Thus y is the criterion measure for criterion g. Let $\phi_i \in \Phi$. Then $y = \phi_i(x)$ defines a specific program under the i-th treatment.

Remark: Rationally, there are only a finite number of treatments selected from Φ to be applied on the input x. Moreover, due to finite time, the manager makes only a finite number of adjustments. (Although finite, there could be thousands of specific ϕ_i thus satisfying the most complicated experiment.) Hence $\Phi = \{\phi_1, \phi_2 \cdots \phi_s\}$.

Definition 1: An experiment on the i-th treatment occurs in the time interval $[t_o, t_n]$. For any given t, we define an observation function $\theta_t: \Phi \rightarrow [0, 1]$ as $\theta_t(\phi_i) = \alpha$ iff $(100 \cdot \alpha)$% describes the maximum possible extent of criterion achievement for ϕ_i. Thus $\theta_t(\phi_i) = 0.75$ means that ϕ_i could effect 75% of the transformation of some x to g_i. Clearly $\theta_t(\phi_i) = 1.0$ means that ϕ_i reaches its goal. Let α_o, for a sufficiently small value of α, be ineffectual criterion achievement.

Remark: Given any interval $[t_1, t_2]$ and $\phi_1, \phi_2 \in \Phi$ the probability that $C_i(\phi_1)$ and $C_i(\phi_2)$ trace identical paths is strictly zero; hence, there is a distinct $C_i(\phi_i)$ for every $\phi_i \in \Phi$.

Definition 2: Given any interval $[t_1, t_2]$ and $\phi_1, \phi_2 \in \Phi$ we define $d(\phi_1, \phi_2) = \sup_t \{|C_i(\phi_1) - C_i(\phi_2)|_t\}$. Clearly $\langle \Phi, d \rangle$ is a metric space. Set $\epsilon_m = \min \{d(\phi_i, \phi_j);\ i \neq j;\ i, j = 1, 2 \ldots s\}$.

Definition 3: Given t_n, if $d(\phi_i, \phi_0) \approx 0$ for ϕ_0 the identity transformation (null treatment), then there essentially is no i-th treatment effect.

Remark: By Definition 1 and the appended Remark, there is a distinct $C(\phi_i)$ for every ϕ_i, including ϕ_0. Hence $d(\phi_i, \phi_0)$ cannot equal zero.

Axiom 3: There exists a rational manager's response $R: \Phi \to \Phi$, where $R(\Phi) = \Phi^*$ is characterized by the condition

$\Phi^* = \{R\phi_i \mid \phi_i \in \Phi, C(R\phi_i) \geq C(\phi_i)$, and given $\epsilon_m = \epsilon > 0$ there is a $\beta < 1$ such that $C(R\phi_i) \in [\beta - \epsilon/2, \beta + \epsilon/2]\}$.

Lemma 1: $\langle \Phi, d \rangle$ is a complete metric space.

Proof: $\langle \Phi, J \rangle$ is complete for any Φ finite.

Lemma 2: $R: \Phi \to \Phi$ is contractive.

Proof: Let $\in_m$ be given. For every $\phi_i, \phi_j \in \Phi$ and $\phi_i^*, \phi_j^* \in \Phi^*$

$i \neq j$ we have

$$0 < d(\phi_i^*, \phi_j^*) < d(\phi_i, \phi_j)$$

or

$$0 < \frac{d(\phi_i^*, \phi_j^*)}{d(\phi_i, \phi_j)} < 1.$$

Since i, j range over a finite set Φ, there is a $k \in [0, 1]$

such that

$$0 < \frac{d(\phi_i^*, \phi_j^*)}{d(\phi_i, \phi_j)} \leq k < 1.$$

Hence

$$d(\phi_i^*, \phi_j^*) \leq k\, d(\phi_i, \phi_j) \quad \text{for all } i, j.$$

Thus R is contractive and the lemma is proved

Theorem: R has a unique fixed point ϕ_ω.

Proof: By the contractive mapping theorem, if $\langle \Phi, d \rangle$ is a complete metric space, and $R: \Phi \to \Phi$ is contractive with a coefficient of adjustment k, then R has a fixed point ϕ_ω. For any r iterations of R, and any $\phi \in \Phi$, $\{R^r \phi\} \to \phi_\omega$. Thus ϕ_ω is unique.

Remark: ξ_s is the stable treatment value. Given this stable value, the researcher can confidently predict the outcome of program operation. Thus he realizes his goal. The program manager has, by his stabilizing of ξ_s realized his goal.

NOTES

[1]J. L. Price, "Design of Proof in Organizational Research," Administrative Science Quarterly (1968) pp. 121-122.

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